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HEEDE

CONCRETOR

SLIPFORM EQUIPMENT

B. M. HEEDE, INC.

80 Broad Street
New York 4, N. Y.

CONCRETOR SILOS
REG. TRADE MARK
U. S. AND FOREIGN PATENTS

Sliding Forms

certainly cannot be construed to be something new in the engineering field. However, the Concretor System of raising the forms is new. Architects, structural engineers and others in the field of construction will find this system simple in design, application and operation.

COVER

Sponge Iron Plant, Persberg, Sweden.

Constructed with Concretor Slipform and Hydraulic Jacks in nine days continuous pouring. The 107-ton roof skeleton was raised with the form 99 feet as the walls were poured. For further details *see page 28.*

B. M. Heede, Inc.

introduced the hydraulic jack principle of raising slipforms to the United States late in 1949, through an exclusive license arrangement granted by A. B. Byggforbattring, a Swedish engineering firm with worldwide patents covering their equipment. In association with Mr. Emrik Lindman, engineer and inventor, the Concretor (known as Prometo in Europe) slipform equipment has, to a point, revolutionized certain types of construction in Scandinavia, and Europe as a whole.

The purpose of this catalog is to call to the attention of the construction industry the adaptability and conclusive results obtained with Concretor equipment in all phases of construction.

On the next page will be found a table of contents. Regardless of your interests we feel sure you will find at least one of the subjects applicable to your field.

We solicit your inquiries with or without drawings and will be pleased to review and offer our suggestions on any contemplated construction whether large or small.

CUSTODIS

CONSTRUCTION COMPANY, INC.

GENERAL OFFICE
25 BROADWAY, NEW YORK 4, N.Y.

BRANCH OFFICE
22 WEST MONROE ST., CHICAGO 3, ILL.

New York 4, N. Y.

February 24, 1953

B. M. Heede, Inc.
80 Broad Street
New York 4, N. Y.

Gentlemen:

We recently completed the erection of six 40' concrete pedestals, using your Concretor equipment. The inner diameter of these pedestals was 17' and the wall thickness was 34".

We want to tell you that in our opinion the Concretor equipment turned out this work in a minimum of time and with a corresponding reduction in cost over methods previously used. With the use of these forms honey-combing was eliminated both on the inside and the outside of the pedestal, and produced a very workmanlike structure.

We are well pleased with the performance of the Concretor equipment, and should we have the opportunity to recommend it, we most certainly will.

Very truly yours,

CUSTODIS CONSTRUCTION COMPANY, INC.

G. E. Horne, President

GEH:rmc

SALES OFFICES: ATLANTA · BOSTON · CLEVELAND · DETROIT · LOS ANGELES · MILWAUKEE · MINNEAPOLIS · PHILADELPHIA · PITTSBURGH · PORTLAND · ST. LOUIS · SAN FRANCISCO · SEATTLE

UNITED ENGINEERS & CONSTRUCTORS INC.

ADDRESS REPLY TO FIELD OFFICE.

April 24, 1952

B. M. Heede, Inc.
80 Broad Street
New York 4, New York

Gentlemen:

We have just completed pouring a 60' silo using your "Concretor" method.

I would like to take this opportunity to comment on your process.

We were able with your method to complete the job in a minimum amount of time, which resulted in a great reduction of cost.

We were especially pleased at the absence of "honeycomb", both on the interior and exterior surfaces.

We are pleased to recommend your process and assure you that in the future your method will certainly be considered for all work of this type.

Yours very truly,

UNITED ENGINEERS & CONSTRUCTORS INC.

Chas. G. Norkett, Construction Supt.

B. M. Heede, Inc.

80 BROAD STREET
NEW YORK 4, N. Y.

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Common Methods of Form Raising

For casting of monolithic concrete constructions of great height, i.e., silos for storing grain, cement, coal, slag, etc., the method of sliding forms is often used. With such high constructions fixed forms will not be economical as to material and working time. The sliding form usually has a height of 3 - 6 feet (0.9 - 1.8 m.) and despite the fact that this form, in comparison to the fixed form, must be built with more precision and of heavier material of better quality, it is notably cheaper per square foot of constructed surface. Naturally, the higher the construction, the less the cost.

Until recently the most common way to raise the form has been with screw-jacks or some other similar manual operation. The yokes, which are usually made of wood and tied together with bolts, placed 5 - 8 feet (1.5 - 2.5 m.) apart, have been suspended with a certain type of screw or jack arrangement on a steel jackrod, usually $1\frac{1}{8}$ inches (28 mm.) The raising is done by a team; the number of men required for raising the form alone being considerable (Fig. 1). Besides this, the fact that the work must continue day and night greatly increases the labor during pouring. This is a notable disadvantage partly because of the desirability of keeping the number of workers constant on the job and partly because of the frequent shortage of laborers. At the same time the labor cost for the form raising only will be too high.

Another disadvantage of manual form raising is the difficulty of keeping the form moving at an even rate of speed and at the same time keeping it level because of the number of screws or jacks each man has to operate, i.e. certain cases 1 to 5. The more jacking points, the greater the difficulty. Accordingly, the form, as it goes up, is exposed more or less to irregular deformations. Not only are the strains and stresses on form construction irregular, but at the same time there is a danger of local pressures between form and concrete of such strength that the concrete cracks.

Photo: Courtesy—Architectural Forum Press Release Photo

Fig. 1—Screw Jack Method

Hydraulic Form Raising

To eliminate the disadvantages which follow common methods of form raising, a new method (Fig. 2) has been introduced in Sweden — Concretor — an entirely new system of form raising. It was started in 1946 and is now used in Denmark, Finland, Norway, Iceland, France, Holland, Germany, Italy, Austria, England, Portugal, South Africa, South America, U.S.A., Mexico and Australia.

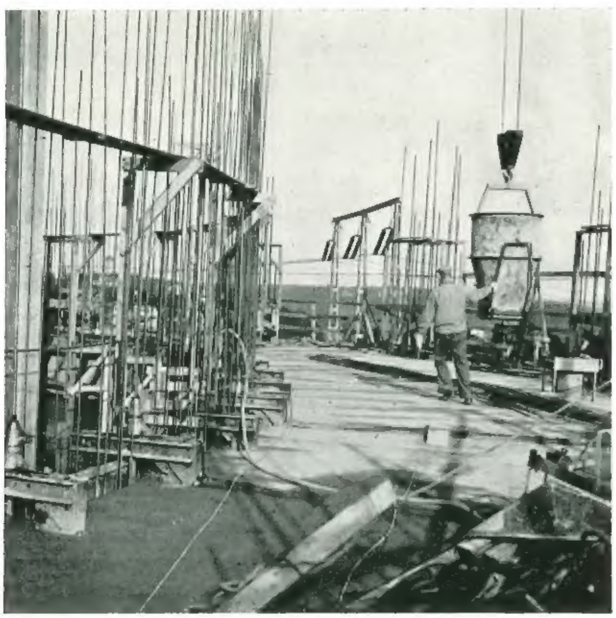

Fig. 2—Hydraulic Jack Method

The new method has as its objectives to:

1. Reduce to the lowest possible point the manual labor connected with the lifting of the form.
2. Increase the lifting speed.
3. Produce uniform and simultaneous ascent at the different points where the lifting power is applied.
4. Simplify all other work in connection with slide casting, such as conveying concrete to the form, its distribution in the form, assembling and dismantling of the form and the structural parts which support it, etc.

The jacking equipment consists of a number of hydraulic jacks on which the form equipment is suspended. These jacks are connected with oilpipes to a small electric powered oil pump. When this is started, oil is pushed by pressure to the jacks which all start to raise at the same time. Each jack (Fig. 3) "climbs" on a smooth round steel rod with a diameter of 1 inch (occ. 1¼ inches) and each raise is 1 inch (25 mm.).

By using the right interval between raises, a desired raising speed up to 20 inches (0.5 m.) per hour can be obtained. Naturally, the raising speed coincides with the growing strength of the concrete, depending on weather conditions, the capacity of the mixer, distribution of concrete, working concrete in the form, reinforcing, etc. In addition the proper speed must be chosen so that the form does not adhere to the concrete.

With this system of raising only one man is needed for operating the jacks, regardless of the number of jacks used. The only thing he has to do is start the pump. When the number of jacks used is less than 10 to 15, he can even take part in other work on the platform. Furthermore, the raising

Fig. 3—The Jack

can easily be speeded up or slowed down, depending on circumstances, and can be kept as high as the strength of the concrete and working organization permit. The even and simultaneous raising at all points of the form prevents the form from slanting, eliminating breaking and tensions against the concrete.

Joining of the jackrods is done with threaded studs and this operation can be accomplished very quickly by the same man who watches the raising. Thus raising the form can be taken care of by one man who has only to start the electric pump.

In this connection it should be worth mentioning that a very simple method makes it possible to regain the jackrods for use over and over again. This is a common procedure with our system, being done quite often. A three foot long pipe is connected to the lowest part of the hydraulic jack protecting the jackrod from coming in contact with the unset concrete. Consequently, the jackrod will be standing in a small vertical hole in the wall instead of being imbedded. After completion of a project, therefore, the jackrods can easily be drawn upward using a special lever device.

Standard Slide-Casting Machines

THE possibility of simplifying other work in connection with slide-casting is closely related to the possibility of standardizing the horizontal section of concrete constructions which apply to slide casting. Of course, in many cases, "standardization" may not be desirable: but if one looks at a round tank or silo for storing sand, grain, feed for cattle, etc., it should be possible, without difficulty, to use a machine with an even diameter measurement without the "individual" impression being lost. This has proved satisfactory especially in connection with farm silos.

Fig. 4—Silo during erection

The fact that there is a great need for these and other types of silos has proved the desirability of manufacturing a number of standard machines for slide-casting of silos or towers with an inner diameter from 6 - 26 feet (1.8 - 8 m.) with an interval of approximately 3 feet (1 m.) (Fig. 4). Such machines have 4 foot (1.2 m.) high forms. The framework for supporting the platform is made of sheet steel and iron beams, while the platform is made of plywood in sections. The different parts can be assembled easily with bolts and suspended on three or six jacks.

On top of the form is an electrically-driven hoist with which the concrete is lifted in a bucket. The hoist is rotated over the platform, and the concrete is emptied into a distributor furnished with wheels and revolving round the center pole. From this the concrete can be distributed directly anywhere in the form.

The wall thickness can be adjusted from 5 - 8 inches (12.5 - 20 cm.) for the smaller size machines and from 6 - 10 inches (15 - 25 cm.) for the larger. With normal type slide casting, machines up to 16 feet (5 m.) are operated by only two men per shift. One works on the ground operating the mixer and taking care of the reinforcing steel. The other works on top hoisting concrete and steel, pouring, reinforcing and raising the machine.

With the larger machines a larger crew is naturally required (Fig. 5).

For casting of farm silos to a height of about 65 feet (20 m.), the crew consists of 3 - 4 men who split up the working time in shifts. The normal pouring speed is about 24 feet per day. Therefore a 60 foot silo can be poured in only three days. The assembling of the machine and setting of the reinforcing steel within the form height on a previously poured foundation takes approximately 5 hours. The dismantling takes about the same time, using a special winch with three cables to lower the framework and form to the ground where it can be taken apart (Fig. 6). Including loading and unloading of truck, trucking to new site and pouring of the foundation, a regular crew can build one silo a week (Fig. 7).

About 700 silos and towers up to 245 feet high have been built with these standard machines. While most of them were designed for storage for the agricultural industry, many have been put to other uses, such as pockets for sand and slag, tanks for road construction material, pillars for aerial wire rope, railways and traverses, lighthouses and similar purposes.

Fig. 6—Dismantling outer form at No. Chatham, N. Y.

Fig. 5—Grain Silos in process of erection

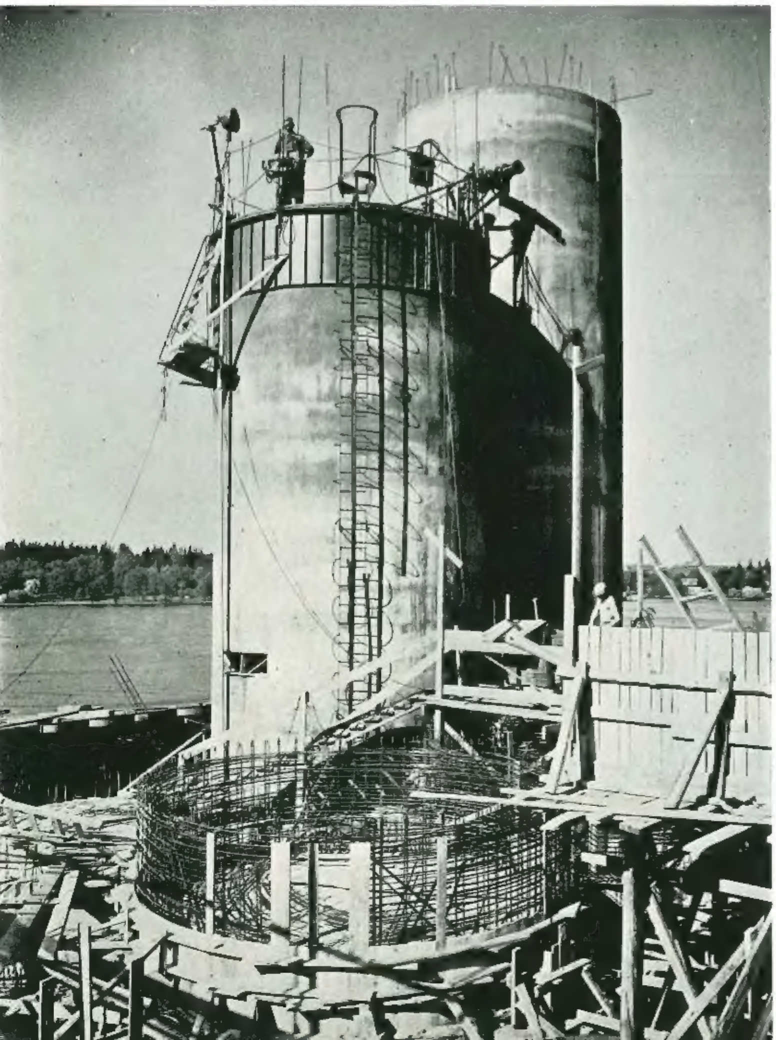

Fig. 7—70 foot high farmsilo at Lowville, New York, constructed in 74 hours

VENTILATING CHIMNEY

A special type of slide casting work, where the standard machinery was used, is worth describing more closely—a 230 feet high ventilating chimney. The chimney was built on top of a 100 foot high foundation inside a big industrial building (Fig. 8). The chimney was circular with an inner diameter of 13 feet (4 m.) and a wall thickness of 8 inches (20 cm.). The form and jacking equipment were of the type described previously. With consideration given to the great height, hoisting of concrete and reinforcing steel was done on the inside.

The hoist was placed on an upper platform about 8 feet (2.5 m.) over the working platform and furnished with an automatic switch so that the concrete bucket stopped, without manual attention, in top as well as in bottom position. The starter for lowering and hoisting the bucket was manually directed on the top or on the ground. In doing so, special signal lamps showed whether the hoist was operating upwards or downwards. When the bucket had passed the opening in the working platform and had stopped in top position, the revolving concrete distributor was turned in over the opening and the concrete was emptied on the distributor, which was then turned to the place where the concrete was to be placed in the form.

The reinforcing steel was placed in the middle of the wall and consisted of ¾-inch steel with a breaking limit of 62,500 lbs./sq. in. (St. 44), c/c 5 inches in the bottom and ⅝ inches, c/c 10 inches in the upper part. The lengths of the individual rods were 20 - 21 feet (6 - 6.5 m.); they were kept in right position with double guiding rings. To avoid a timewasting simultaneous joining of all vertical steel, the reinforcing was of different lengths and placed at varied intervals. This arrangement was accomplished by starting with varied lengths of reinforcing at the beginning, so arranged that the rod ends form two rising screws with the beginning of the thread placed diametrically. In this way there was a need of two rods about every half hour. These rods were hoisted up with the concrete. Simultaneously with the slide casting an outside ladder and hoop for protection had to be cast into the concrete. This was so arranged that two special form cuts were made in the outer form reaching from the lower edge up to 8 inches below the upper edge. During the pouring, there were successively placed double standing wood pieces 3 inches by 1½ inches, with drilled holes, where the shanks of the ladders and hoops were continuously placed in the upper part of the fresh concrete, and furnished with washer and nut for anchoring in the concrete. A few feet below the form, where the concrete was hard enough, the wood pieces could easily be taken apart and removed.

The surfaces of the inside and outside were finished from underneath the form using a hanging scaffold. A continuously built scaffold inside gave workers access to the platform. The work was done in shifts with a pouring speed of about 13 feet 4 inches per day. The complete crew per shift was five men.

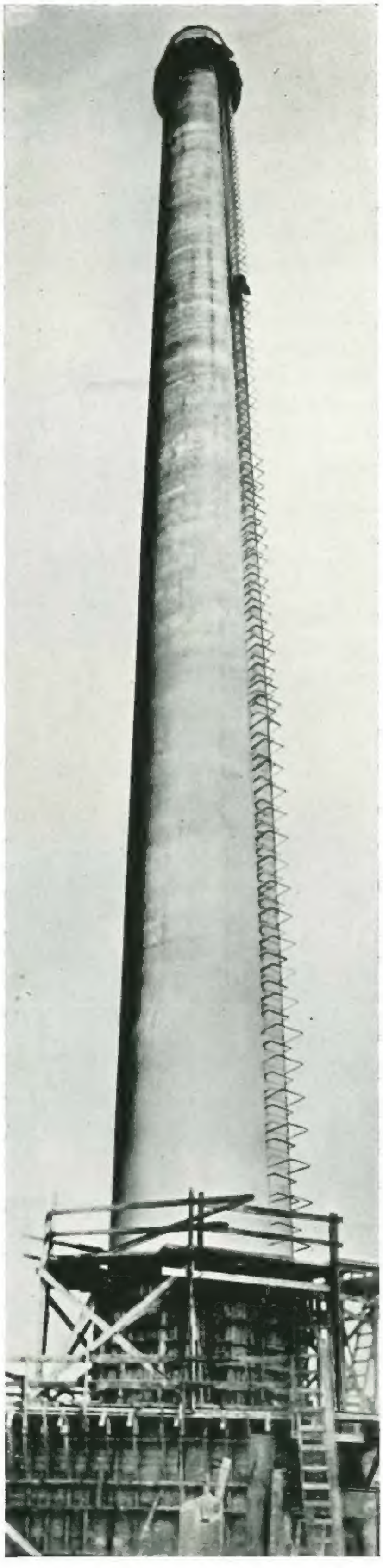

Fig. 8

CHIMNEY PEDESTALS IN KENTUCKY.

Another job where a modified standard machine was used with success was at the Shawnee Steam Plant near Paducah, Kentucky. Custodis Construction Co., Inc., Chicago, erected six pedestals in the course of 30 working days (Fig. 9) during the fall of 1952. Each was 49 feet (15 m.) high and had an inner diameter of 17 feet (5.2 m.) with a wall thickness of not less than 34 inches (0.87 m.).

As the raising speed was about 10 inches (0.25 m.) per hour, a considerable amount of concrete was required which was hoisted inside a steel tower. At the bottom of the tower a bucket was loaded through a chute from the mixer and then hoisted to a vertically moveable platform which was always a little higher than the slip form. From this platform the bucket was emptied into another chute from which the concrete was transported in a barrow to the form. The standard hoist could not be used here to advantage owing to the close vertical reinforcement.

The work was carried on in two shifts; one from 6:30 a.m. to 4:30 p.m. and the other from 5 p.m. to 2:30 a.m. During the four hours pause the operator remained on the form and made a lift now and then to prevent the concrete from adhering to the form.

The most remarkable part of this job was the efficient manner of resetting the slip form as well as other equipment such as tower, mixer and hoist. Tennessee Valley Authority, for whose account the pedestals were erected, had one of their large cranes with a 100-foot boom on this job during the operation. The crane lifted the form from an extended center pole direct from the top of one pedestal to the foundation of the next to be poured. In this way it was possible to start a new pour shortly after the previous one was finished.

As soon as the form was moved to a new foundation, the jack rods were recovered to be used over again resulting in considerable saving. The entire chimney was not poured with the Concretor machine, as the tapered requirements of the chimney prevented the continued use of this method beyond the 49-foot base.

Representative of the success which the Custodis Construction Company felt in having used our system in this work, is the fact that they have since requested and received, an exclusive arrangement for chimney construction in the U. S. with Concretor machines and equipment.

Fig. 9

Photo: Courtesy of T.V.A. and Custodis Construction Co., Inc.

Standard Equipment for Wood Slip Forms

When slide casting is used for larger silo groups, construction of buildings of different appearance or round towers with different diameter than the previously mentioned standard sizes, this new method of jacking has been used in combination with wooden forms. The jacking equipment itself is the same as before. The jacks are attached to special yokes of steel on which the wood form is suspended. These yokes are adjustable and made to fit any wall thicknesses and designs of the wood form, and they can easily be assembled and dismantled. As previously mentioned, with this jacking method the form is exposed to considerably less stresses and strains than in the use of other systems. Therefore, the construction of the form can be made comparatively simple.

Silo Constructions for Grain Storage

The silo group shown in figure 10 consisted of 10 square cells 16 x 16 feet (5 x 5 m.) with a total measurement of 82 x 33 feet (25 x 10 m.), a height of 62 feet (19 m.) and a wall thickness of 7 inches. The form was 3½ feet high and made of 1½ inch planed boards with two horizontal walings 4 x 4 inches, one at the upper edge of the form and one 10 inches above the lower edge of the form.

The inside form was made tapered with a clearance of ¼-inch. The form was suspended on 54 standard yokes, placed symmetrically with two yokes at each side of the cells at an equal distance of about 9 feet (2.75 m.). The working platform which was placed level with the upper edge of the form, was partly intended as a transport surface for the concrete wheel barrows and partly as a form for the roof to be used after pouring of the walls was finished. To simplify later dismounting of this form, when the roof was poured, the whole working platform for each cell was suspended on two

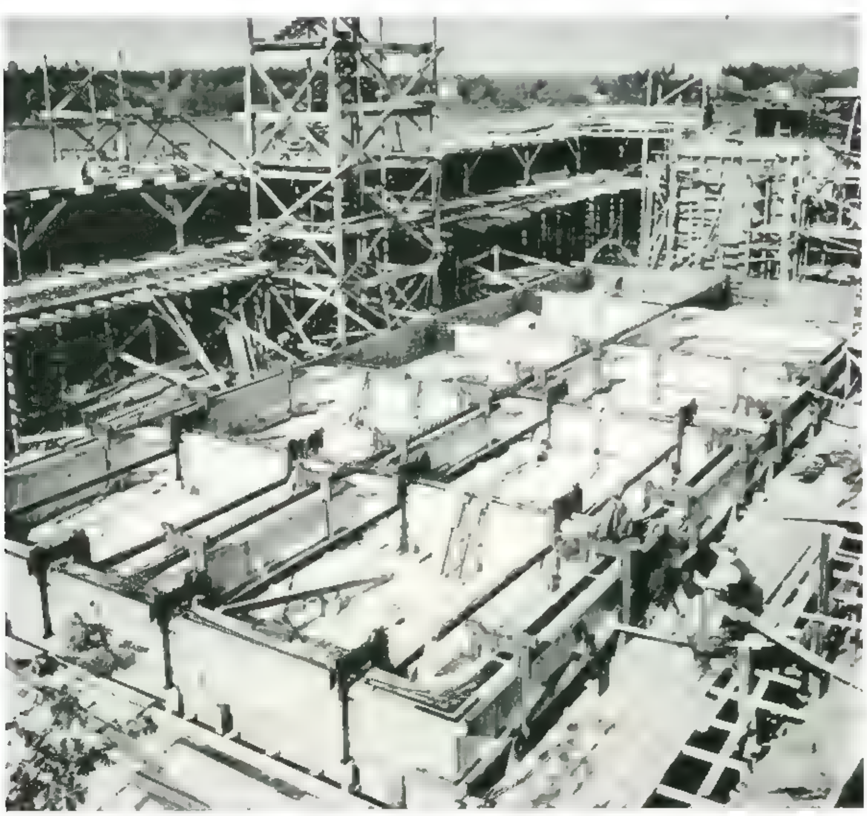

Fig. 10—Assembling wooden slip form

steel beams with the ends joined to the yokes. On these steel beams were laid wood beams 2 x 6 inches and on top of that a floor made of 1½-inch lumber.

Raising of the form was done with 54 jacks. All jacks were operated by a system of oilpipes connected to an oil pressure pump. As the yokes only reached about 16 inches above the platform and the oilpipes were placed at a sufficient height, there was nothing impeding the transport of the concrete or other work on the platform. The concrete was lifted in a bottom-dumping bucket with a friction hoist with revolving arm on a fixed frame. For hoisting of the reinforcing steel, a small electrical telfer hoist outrigged from the slip form was used (Fig. 11). Accordingly this hoist followed upward with the form and was operated from there. For controlling the level of the form, water levels were used and were placed in the outer corners and in the middle of the longest sides.

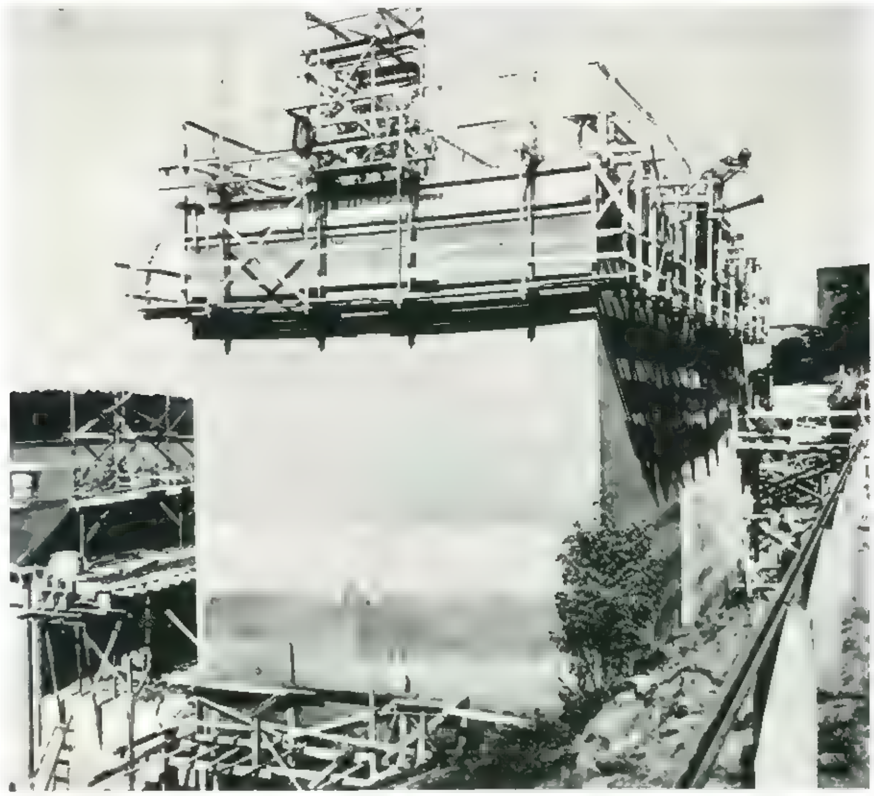

Fig. 11—Note hoist on platform on right side of form

The casting was accomplished in three 8-hour shifts. Each shift consisted of 9 men for mixing and transportation of concrete, receiving, vibrating and reinforcing; one man for finishing of the outside wall and for odds and ends; and one man for raising the form. Required time for casting of the 62 foot (19 m.) high concrete monolithic structure was 6 days. The sliding speed, which in this case was about 10 feet per day was not decided by the setting time of the concrete or the possible raising speed. The decision in this case was the capacity of the mixer and the hoisting arrangements required plus the available number of men for pouring and reinforcing.

The concrete mixture consisted of 550 lbs./cu. yd. (325 kg/m.^{3}) of cement and a maximum size gravel of 1¼ inches. The barrel type mixer mixed ½ cu. yd. (350 l) of concrete at a time. For each foot of height 10 cu. yds. (25 m^3/hm.) of concrete was required. All silo walls were double-reinforced with a c/c distance of the horizontal bars as multiples of fixed measurements. Because the layer of concrete was adjusted for these measurements, putting in the reinforcing steel was made easier.

When the concrete roof was strong enough so the form could be removed, the roof form for each silo cell was lowered to a short distance below the lower edge of the wall form with help of four 7 foot (2 m.) long screws (between the yokes and the previous mentioned steel beams). Thereafter, the wall form was broken loose and the roof form was lowered to the bottom of the silo with help of a hand winch and a cable attached to the centre of the form.

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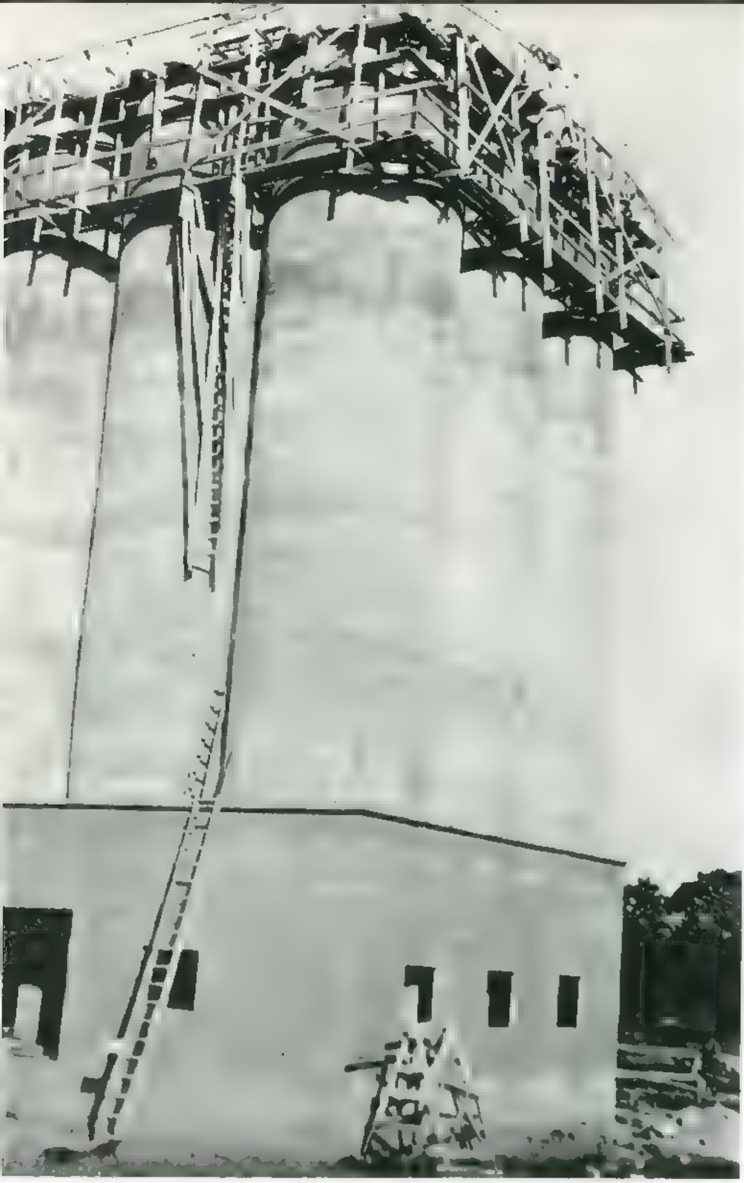


Fig. 12

The silo group (Fig. 12) consisted of 15 round cells with a diameter of 10 feet 6 inches (3.2 m.) and 8 star cells. The same jacking equipment and yokes described before were used. The number of jacks was 50. The silo group was cast in conjunction with a previously built building. The slip form was forced to follow the wall of this building, which was accomplished with successively placed wood beams. The form was made of 1¼-inch planed boards. The height of the form was 3 feet 6 inches (1.05 m.), the horizontal walings consisted of 2 x 8-inch planks, held together with bolts and tooth plates. The form of the star cell was not raised direct by the yokes but was suspended in the form of the adjoining round cells. The pouring time for the 46 foot (14 m.) high silo group was 5 days. The total number of men per shift was 11 plus one man for raising of the form. The outside surfaces were finished.

Fig. 13

The silo building shown in Fig. 13 was built on the same principles as outlined in the foregoing text. The working platform was supported on steel beams, attached to standard yokes carrying over the loads of and on the platform centrically to the lifting points. On the working platform a friction hoist with pole and revolving arm was placed with which the concrete was hoisted from within, the mixer being placed inside. The casting speed was comparatively slow, about 7 feet 6 inches (2.3 m.) per day because of unfavorable weather conditions, snow and temperature down to 14° F. (– 10° C.). All materials had to be heated; the cement arrived warm direct from the factory.

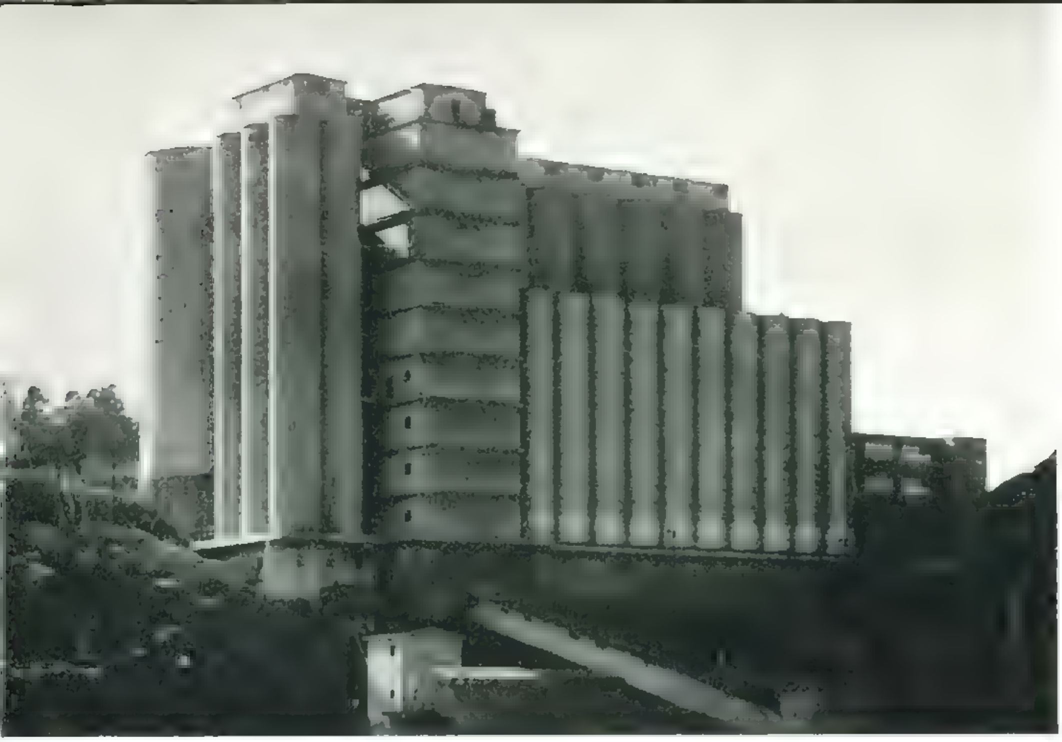


Fig. 14—Grain bins enlarged by using the Concretor system

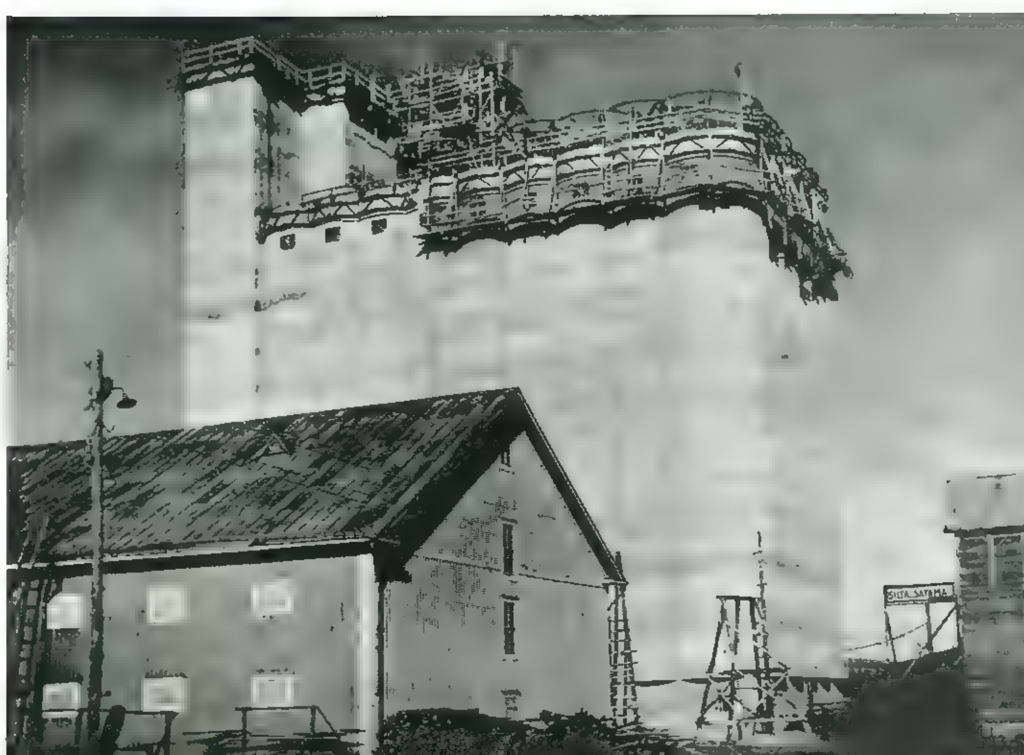


Fig. 15—This large grain structure was raised with the Concretor method.

Fig. 16a

Fig. 16b

14

Fig. 16c

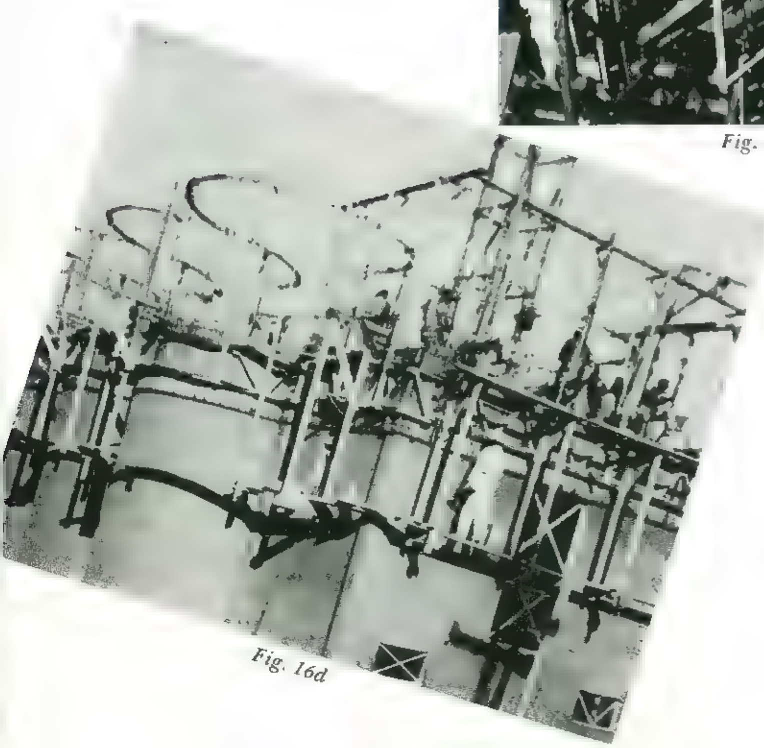


Fig. 16d

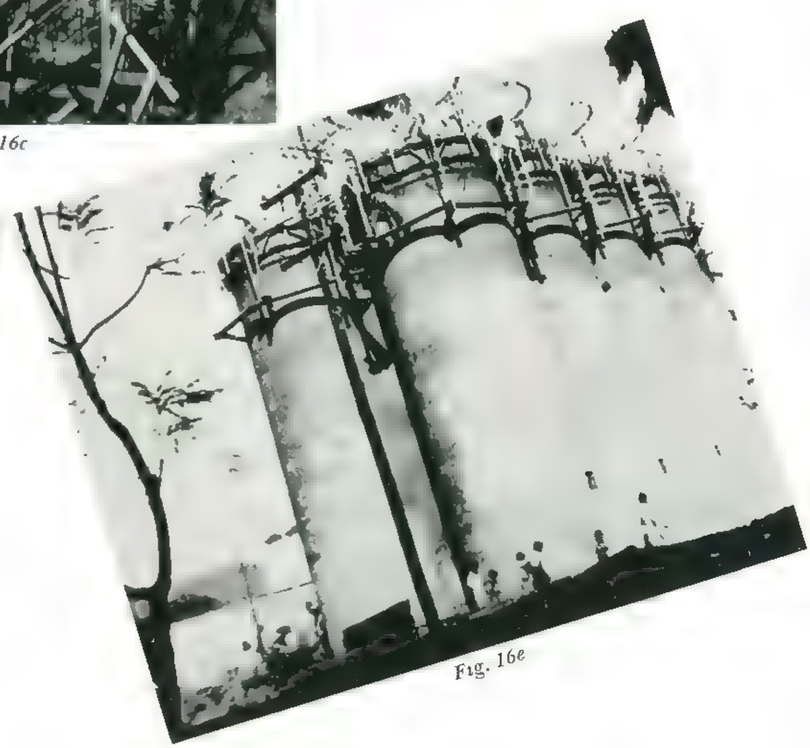
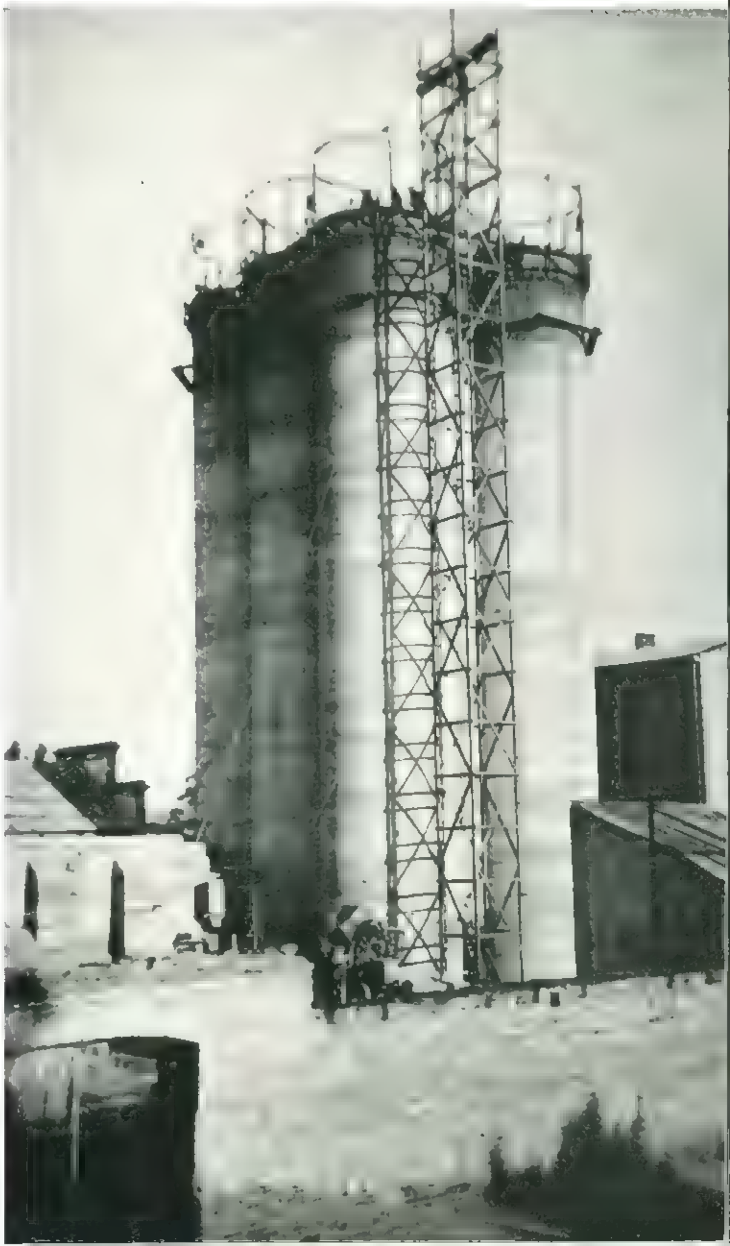


Fig. 16e

Fig. 16f

Fig. 16g



Jiquilpan, Mexico. Eight grain storage tanks, with elevator, 66 feet high. Tanks had an inner diameter of 14′ 10″, with a wall thickness of 6″. The size of the grain elevator was 11′ 8″ x 21′ 4″ with a wall thickness of 7″.

On page 14 will be found a series of photos beginning with the attaching of standard yokes to the wooden form, Fig. 16a. The working platform and forms assembled, Fig. 16b, with guiding rings for vertical reinforcement are very clearly shown, Fig. 16c. Fifty-six jacks were used in raising these tanks and elevator. Fig. 16d shows the construction proceeding the second day with hanging scaffolds in place for finishing and painting if required; inside scaffolds were also used. A maximum raising speed of 10″ per hour was reached and maintained during certain periods of this construction. The nearly completed structure showing 4½′ interstice walls, Fig. 16e, has three star cells for additional storage.

The photos, Fig. 16f and 16g, show another battery of silos constructed at Irapuato, Mexico, identical in size to those shown with the grain elevator on preceding page. Thirty-four jacks were used in this instance. Once again interstice walls were used and you might note the grooves shown in the silos which have been made for adding another group of silos at a later period.

All jackrods in both cases were recovered for reuse resulting in a very favorable saving in material costs.

Fig. 17—Askim, Norway. Grain elevator

Fig. 17—a, b, c showing transportation of concrete on upper platform with distribution through chutes to the working form

Apartment Houses of Concrete

THE idea of using slipforms even in the construction of apartment houses of concrete naturally follows. After some years experience of the practical function of the hydraulic raising method and some preparatory work, several large houses of the star type were erected with slipforms. Two different principles were used in pouring the walls and the flooring.

CONTINUOUS POURING

During the spring of 1950 one seven-story and two eight-story houses were erected in Stockholm.

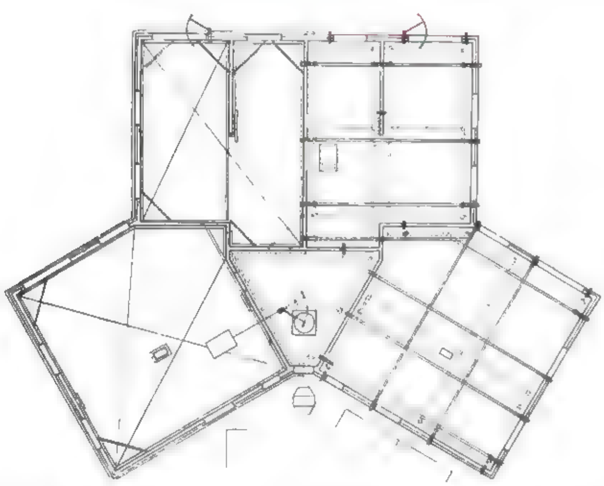


Fig. 18—Principal outline of working platform for slip form and flooring form

The hydraulic form raising and construction of the form was the responsibility of AB Byggforbattring, Stockholm. Starting point for the erection of the building frame was, first, all outer and inner walls should be slide cast continuously to the top floor. Following this, the floors, should be poured with the help of a form lowered from the top and working downward.

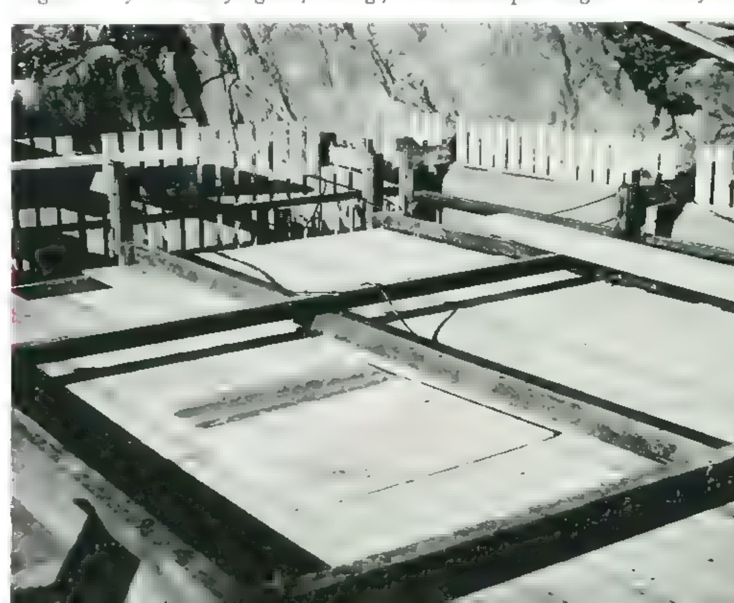
Plan of the Building

The three houses have exactly the same plan of the so-called star-type, which allowed a repeated use of the same slip form. The largest extension of the building plan was 63 x 86 feet (19 x 26 m.) with an area of approx. 5400 sq. ft. (325 m.²). Each story contains two apartments with three rooms and kitchen and two with two rooms and kitchen. The wall thickness of the supporting inner walls is 6 and 6½ inches for the outer walls plus 5 inches outside insulation of lightweight concrete blocks. All walls have double reinforcing. All outer and inner supporting walls and two columns with dimensions of 1 x 2 feet (0.3 x 0.6 m.) were slide cast.

Construction of the Slip Form

Considering that the form was to be used several times, it was made so that assembling and dismantling could be done easily. The form was 1½ x 5 inches planed boards which were nailed to form sections of 8 to 9 feet (2.5 - 2.8 m) lengths. The height of the inner form was 3 feet 5 inches (1.05 m.) and the outer form 5 feet 5 inches (1.60 m.). On the outer form the boards were nailed 2 inches apart. The walings on which the form sections were suspended, consisted of channels on the top as well as on the bottom of the form. These channel beams had been made and fixed in a work shop and could be assembled on the site together with the yokes with the help of bolts. To get fixed design and to insure unity of opposite walls, a small number of channel beams with centrical attachment to the yokes were suspended on these (Figs. 18 and 19). On these channel beams the working platform was placed,

Fig. 19—Stay beams laying on flooring form and coupled together with yokes



consisting of 2 x 6-inch wood beams with 1-inch boarding. The number of yokes was 54 and at each yoke a jack was placed; each jack was run from an oilpipe connected with the oil pump. To facilitate putting in the pipes for the building, arrangements were made in the form with boards or lathes.

Fig. 20

Form for the Flooring

As the flooring form was to be used later on, beginning from the top, it was ready built on the lower floor before the working platform was built. It was made in four units, one for each apartment and consisted of a carrying horizontal steel frame of beams, on which was built a standard framework of the same type as used for ordinary form building. On this framework were placed form sections, which were covered with hard masonite in order to give the concrete a smooth surface so that plastering would not be necessary. The whole form was suspended on the yokes partly with bolts partly with a few long screws, with which the form later could be lowered from floor to floor. On the floor was the previously mentioned working platform.

Fig. 21—Four days' casting

Arrangements on the Site

The concrete distribution center was placed right close to the stairway and consisted of two ½-yd. (350 l.) mixers (one in spare) and a cement silo with automatic weighing. From the mixer the concrete was passed into a steel-covered chute through a window into the stairway and down to a bucket with emptying bottom. The bucket was hoisted with a friction hoist placed on the working platform. It was emptied into a special hopper and from there transported with wheelbarrows.

For hoisting reinforcing steel and lightweight concrete blocks, two hoists were used on the opposite side of the house attached to the form, one of which was operated from below and the other from the top. The lightweight concrete blocks were hoisted in carts and transported to where needed at the outer wall. (Fig. 20).

On the working platform were bending and cutting equipment for reinforcing steel, shed for blueprints and tools, levelling equipment, local telephone for stores on the ground and to the office, stocks of frames for windows and doors and other kinds of frames (Fig. 21). Underneath the working platform an arrangement was made for a simple hanging platform along the walls.

Method of Operation

The work was carried on in two 8½-hour shifts. The number of workers per shift was as follows: a pouring team of seven men, one hoist operator, three men for reinforcing, two men for placing the lightweight concrete blocks, two helpers on the ground, one helper for odds and ends on the working platform and one jack operator; also one to three carpenters for insertion of frames for win-

dows, floorings, building of the steps for the indoor stairway and horizontal bracing of the columns.

The slip form equipment was made ready on the finished flooring over the bottom floor. At the beginning of the pouring and a few feet up, both the mixers were used, which were placed higher than the sliding form, so the concrete hoist was not needed. In this way the forms could be filled quickly. The raising speed during the working shift varied between 5 and 6 inches an hour. During the night shift one man stayed on the platform and made a raise once in a while so the form would not adhere to the concrete.

During the pouring the lightweight concrete blocks were placed loosely against the thin outer form. The window openings were temporarily closed with masonite or sackcloth, and the building was heated with kerosense stoves.

When the slide casting was finished, the whole flooring form was lowered with previously mentioned lowering screws and a small motor. Besides the lowering screws, special suspenders of bars from the nearest cast flooring above were arranged when pouring the floorings. The lower floorings were cast in the usual way.

At the dismantling of form and jacking equipment in the first house a wire rope railway was arranged from the top of this house directly down to the bottom flooring in the next house. With the help of this rope railway, all parts were lowered to place for the next assembling of the form.

3-STORY HOUSES IN ITALY

At the beginning of 1952, Eng. Guido Lambertini of Bologna, Italy, began work as a slip-form contractor in the capacity of Main Italian Licensee of the Concretor Method.

The first object was a small apartment house of three stories, not including the basement. The ground dimensions were approximately 26 x 98 feet (8 x 30 m.), which gave space for four apartments grouped about 2 stair wells.

During the days the foundation work (Fig. 22), was in progress, the wooden slip forms were built at a carpentry shop.

Upon assembling, the recessed forms for the basement doors, etc., were set up first and were anchored to strip irons cast into the bottom foundation. Then the complete forms were set up and finally the yokes were mounted. Before boarding-in the working platform, diagonal braces provided with turn-buckles were inserted at the level of the upper walings. Parallel with the assembling of the form, there was erected a pipe scaffolding in front

Fig. 22

of one of the stair wells. Alongside the pipe scaffolding there was placed a concrete mixer of about 8 cu. ft. (250 l.).

The concrete consisted of so-called porous concrete, which was not vibrated but only tamped in the form by means of a light, flat tamper. The consistency was stiff. The thickness for the outer walls was 10 inches (0.25 m.) and for the inner walls 8 inches (0.2 m.). No reinforcement was used in the walls.

The pouring began at the level of the basement floor. From the floor to basement windows a compact concrete mix was utilized. During a short stoppage in the erection, the recessed forms for the cellar windows were inserted with the upper edge of the slip form as a level, whereupon the pouring was continued with porous concrete, with the alternate insertion of recessed forms for the flooring beams and the window openings of the stories.

The pouring speed was limited to 3 feet 4 inches (1 m.) per 24-hour period, which was the maximum output of the mixing station for one day shift. The pouring of the concrete was terminated for the day at 5 p.m. and the pouring joint was permitted to remain where it was with respect to the upper edge of the form.

During the pouring, the originally-inserted

grooved forms for the windows on the first story were removed and inserted again in the third story. Only two sets of grooved forms were thus used.

The floorings were of the hollow tile type and mounted after the walls had been finished.

After this first very successful test house in his home town, Eng. Lambertini immediately started building residential houses on a large scale in Sicily (Fig. 23). He built in rapid sequence six identical 3-story houses, for which work there was used a tower crane transportation. Furthermore, a steel slip form was used on three of the houses with better results than the wooden form according to Italian opinion.

Fig. 23—In foreground steel form being assembled; in background wooden form at top of completed construction

CASTING STORY BY STORY

An apartment constructed in Stockholm is shown in figure 24. All supporting outer and inner walls were slide cast one story at a time and simultaneously the flooring of each story was made ready. In this way both walls and flooring were finished at the same time.

Plan of the Building

The plan measurements of the building was 50 x 70 feet (15 x 22 m.). Each story contained ten apartments with one room and kitchen; five apartments on each side of a five-foot wide corridor with the stairway on the gable of the building (Fig. 25). This plan involved a comparatively great number of apartment-separating walls, a large area for windows and a large number of channels and drawing of pipes in the walls (Fig. 26). Wall thickness was

Fig. 24—The walls and the floorings were completed in ten weeks

6 inches for inner walls and 8 inches plus 5 inches lightweight concrete block insulation for the outer walls.

Construction of the Slip Form

For material transport on this site a tower crane was used, which had a range reaching any point on the plan of the building. In this way it was not necessary to make an entire working platform within each apartment. For each wall a 4 foot (1.2 m.) wide gangway was built out from the slip form. The slip form itself was made in the same way as described for the other houses with the exception of the walings which were of 3 x 6-inch wood to which the form boards were nailed direct. Seventy-three jacks were used, each one attached to a standard yoke of iron. For extra unity of the form

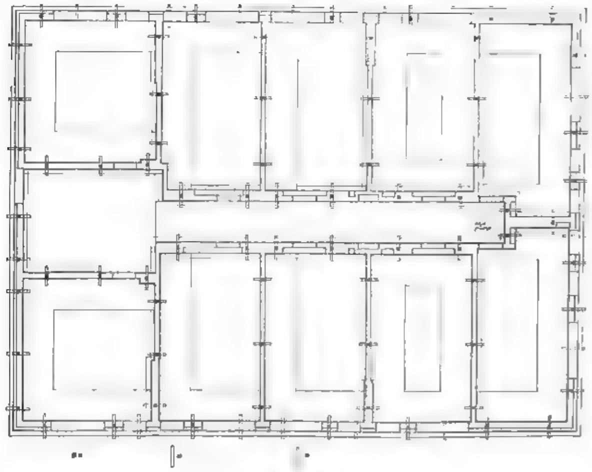


Fig. 25

Fig. 26

there were 14 wood yokes (without raising function) on the parts of the walls where the distance between jacking points was great.

Arrangements at the Site

All material for the concrete station was stored in pockets. The concrete mixer held one cu. yd. (750 l.). For hoisting the concrete two buckets of one cu. yd. volume each were used. The tower crane ran on a track and had a lifting capacity of two tons and a range of 80 feet (25 m.). The crane took care of hoisting concrete as well as reinforcing steel and the lightweight concrete blocks.

Method of Operation

The pouring of the walls was accomplished with only one day shift using the following number of men: one casting team of six men (of which two men were at the mixer), one crane operator, two iron workers, two men for placing the lightweight concrete blocks, one jack operator and two carpenters. At the pouring of the walls the crane operator moved the concrete bucket along the wall, and the receiver let the concrete run in a stream on the gangway close to the wall; about half of the concrete came direct down in the form and the rest of it could easily be shoveled into place. The rest of the men worked the concrete in the form with wood tampers. Before the pouring began, the men had brought up with the crane enough reinforcing steel and lightweight concrete for the shift.

For larger window openings fixed side frames were put down in the form, and for smaller openings complete frames were used. The beams over the larger openings were cast in connection with the floorings. In less than two day shifts, the walls for one story were ready, after which the form raising continued, until the lower edge of the form was in level with the upper edge of the future flooring (Fig. 27). At the same time the reinforcing steel was put in place within the height of the form. The form for the flooring was made, the flooring reinforced and poured in the usual way, and after that began the pouring of the wall over again. The time required for building of walls and flooring for one story was one week.

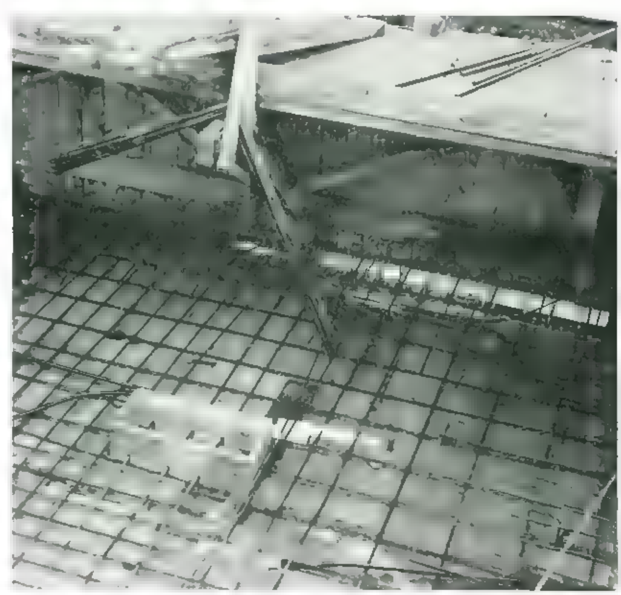


Fig. 27

Fig. 28—With the same slip form, two apartment houses were erected story by story

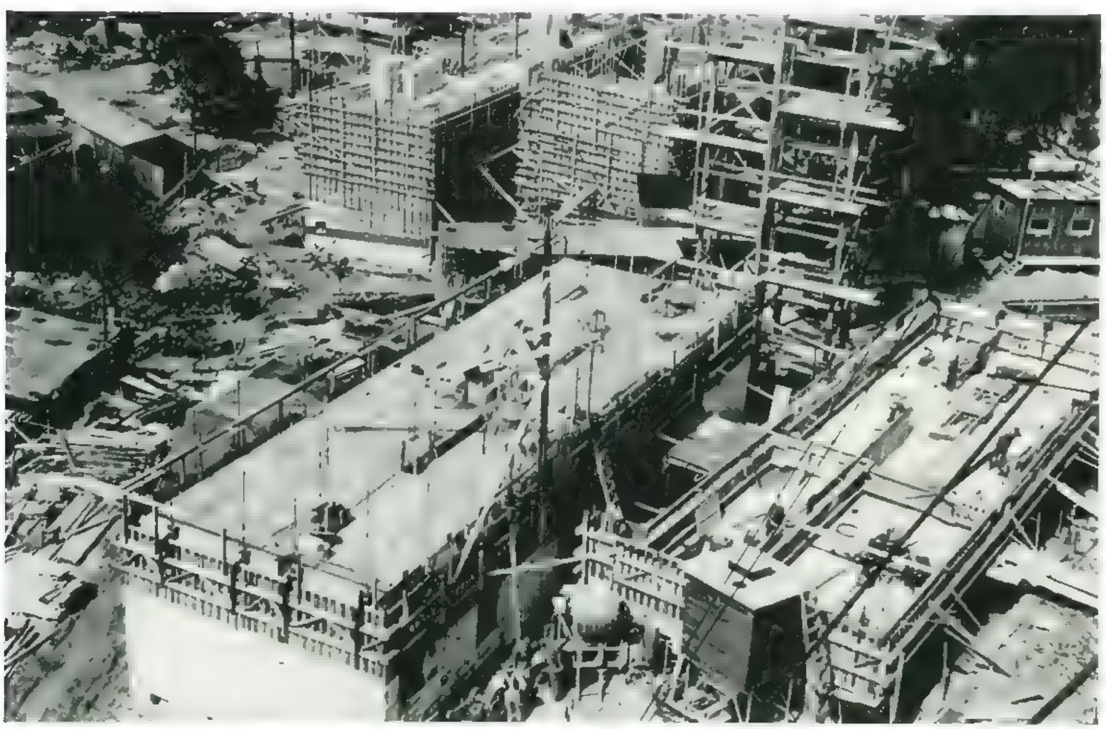


Fig. 29—Note the large amount of wood required in the construction of identical apartment houses in the background by fixed forms, as against the small amount for wooden slip form with the Concretor Method in the foreground

Sub Structures for Water Reservoirs

Most of the water tanks now being constructed are built as high reservoirs. The foundations for these are usually shaped as a cylindrical tower and in bigger tanks in a combination with a circular line of pillars. Usually, these concrete foundations are of such a height, that casting with slip forms is an economical advantage of using hydraulic form raising (Fig. 30). The hoist tower as well as supporting tower and supporting pillars can be slide cast at the same time. Quite a few such foundations have been cast during the past number of years with this method.

Fig. 30—Supporting tower and pillars slide cast to full height

Fig. 31

Figure 31 shows a location where there was already a water reservoir on a foundation consisting of supporting tower with a diameter of 33 feet (10 m.) and eight supporting pillars with a diameter of 5 feet (1.5 m.). This water reservoir was to be entirely surrounded by the new reservoir. The foundation for the latter consisted in part of a circular tower with 100 foot dia. (30 m.) and a wall thickness of 8 inches —and partly of twenty square supporting pillars about 4 x 4 feet (1.3 x 1.3 m.) placed in a circle 150 feet (45 m.) in dia. The height of the substructure was 92 feet (28 m.). For the substructure and the pillars, the slip form was made of wood in the usual way, previously described. The inside bracing in the horizontal plan of the big round form was accomplished with four cables, which had to pass between the existing concrete pillars. Between the circular slip form and the slip forms for the square-shaped supporting pillars, an entire working platform was built. The whole ring-shaped working platform (Fig. 2) was later intended as the form for casting of the bottom plate for the reservoir.

There were 60 jacks for the circular tower and 3 for each of the 20 pillars, or 120 all together. The jacks were divided into two groups, each one with its own oil-pressure pump. These two pumps were started and stopped with a common switch so that the whole form system was raised at the same time. For hoisting of concrete and reinforcing steel they used a centrical coupled horizontal framework arm built on the top of the old water reservoir. This arm ran on a circular track on the edge of the old reservoir. From the center the arm had a length of 83 feet (25 m.), and accordingly extended entirely outside the working platform. Along this arm ran a telfer cart with a capacity of 1.5 tons. The hoist was operated entirely from the top and any place on the working platform could be reached with the material supply.

The concrete station was arranged with four sand and gravel pockets and automatic weighing of the cement. The mixer handled one yard (650 l.) at a time and the concrete was hoisted in a bucket emptied manually. Transport on the platform was not required; the hoist operator could bring the concrete bucket direct to the form (Fig. 2). The number of men per shift was: two men at the mixer, three men for receiving and vibrating the concrete, three iron workers, two carpenters, two finishers, one hoist operator, two jack operators. The pouring speed was 7 - 8 feet (2 - 2.5 m.) per day with continuous pouring.

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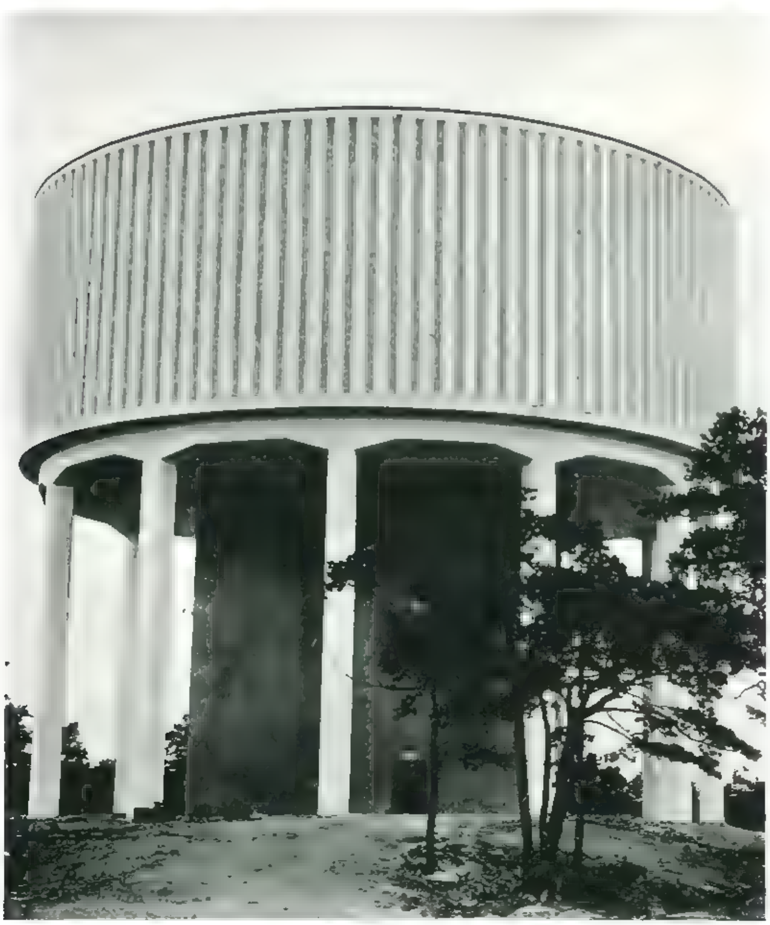

Fig. 32—The substructure for this reservoir was erected with slip form in 1950

Mine Shafts

At the ore mines in Kiruna, Sweden, the construction of the new shafts required going through loose rocks, making it necessary to "dress" the shaft walls with a supporting wall of concrete. The shaft group consists of a shaft for transport of the ore and one elevator shaft for transport of persons and material. Using common concrete casting methods with fixed form the expense and time required for such a "dressing" have always been considerable. In this case it would have been impossible to fulfill the arranged production plan, if pouring was done according to common methods. Therefore, it was decided that the concrete "dressing" should be done as a slip form casting with hydraulic form raising.

The equipment for the slip form had been constructed and delivered by AB Byggforbattring in Stockholm. The casting form was made of sheet steel about 3 feet (1 m.) high, in sections about 3 x 7 feet (1 x 2 m.). It was suspended in a simple steel frame, held together by braces and beams, in which were suspended 6 jacks for the ore shaft form and 8 for the elevator shaft. All parts were made in sections and could be rapidly and simply assembled with bolts. On the beams a wooden working platform was placed.

Under the form there was an inspection platform, suspended by wires to the system of beams on the slip form. On this platform, close to the finished concrete wall, a heater was placed to hasten the setting of the concrete. The temperature in the shaft was 40 - 45° (5 - 8° C.) above zero. Above the main working platform another platform was mounted, on which reinforcing steel, chute for the concrete, etc., were placed. If an insert form should be needed in case of too large a distance between the inner form and the shaft wall, it could be placed from this upper platform. The working platform accordingly was free, and permitted convenient pouring and vibrating work (Figs. 33 and 34).

At the shaft for transport of the ore, the form equipment was dismantled after the pouring was completed and transported down to the next pouring location. At the elevator shaft the casting distances were sometimes quite short. A re-occurring dismantling and assembling of this slip form would

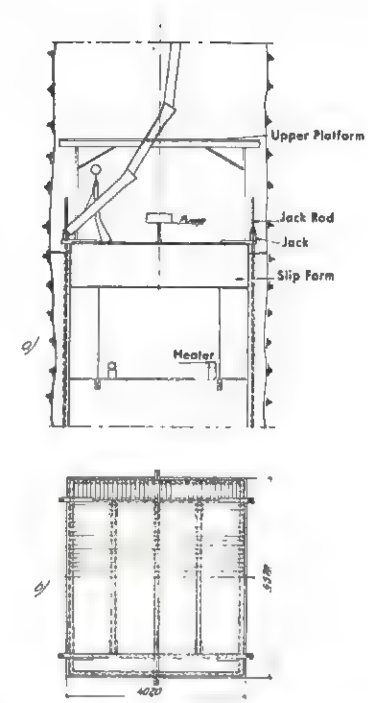

Fig. 33—Casting of kibble shaft by slip form

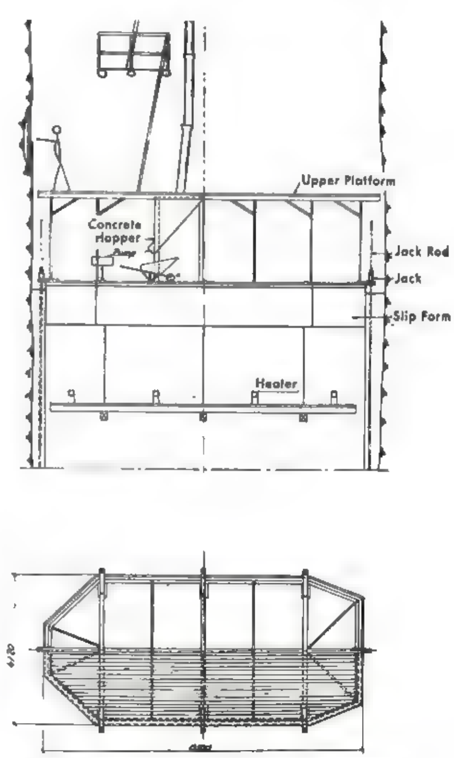

Fig. 34—Casting of hoist shaft by slip form

be too expensive and require too much time. This problem was solved in the following way. After a certain given distance was completely poured, the raising stopped; the rock underneath was then removed and transported from the shaft during which time the form was secured and became inactive. Then the supporting framework with working platform was lowered with the help of two cable winches a good three feet, which automatically loosened the form sections from the framework. These loose form sections were put on the working platform, after which lowering with the winch could continue to where the ore had been removed. Here, the form sections were put in place, and the pouring started again. In this way the dismantling and assembling work was reduced to a minimum. Furthermore, during the lowering one could accomplish certain work such as permanent stairways, etc., direct from the working platform (Fig. 35).

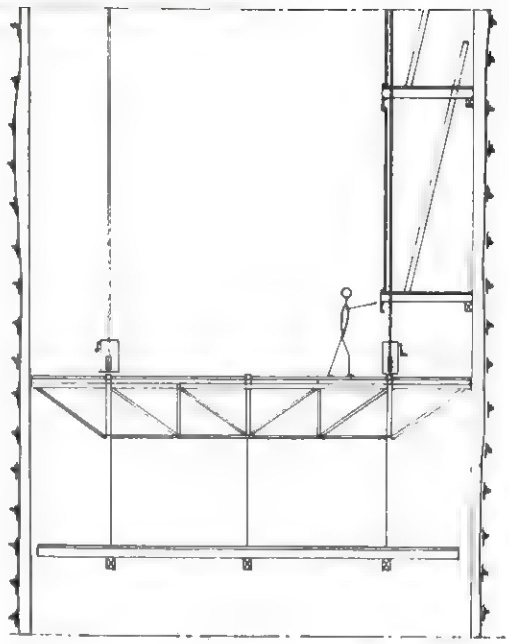

Fig. 35—Slip form in hoist shaft during lowering

The concrete mixing was done with a ½ yard (350 l.) mixer, placed in the adit close to the shaft. The concrete was brought through a pipe down to a concrete hopper on the working platform, from where it was transported in a wheelbarrow to the form. When pouring in the ore shaft, no transport or anything else was needed, the concrete could run directly into the form. The pipes for concrete had been suspended to the shaft wall zigzag and in spite of the maximum height being 260 feet (79 m.) there was no noticeable separation of the concrete. The number of workers casting the elevator shaft was 4 - 7 men depending on circumstances. Of these, 2 - 3 men were on top of the shaft for mixing concrete, bending steel and lowering of material; 1 - 2 men on the upper platform for building of an eventual stationary outer form, demolition of bridges crossing the shaft and receiving of material; and 1 - 2 men on the working platform for reinforcing, pouring, vibrating and form raising. There were 4 to 5 men doing similar work at the ore shaft. The pouring speed was between 10 - 13 feet (3 - 4 m.) per day with continuous pouring.

Pit Head Buildings

Among the pit-head buildings which have been poured with slip forms during the last few years, the building shown constructed in Figure 36 deserves notice for its complicated nature. The pit-head building and ore bunkers, included as a part of the building in a central large concentration plant, were slide cast while the rest of the plant was constructed in the usual way. The work was carried on in two stages, owing to the fact that the height of the pit-head building considerably exceeded that of the ore mill bunkers.

The plan dimensions of the building are about 48 x 76 feet (14.6 x 23.1 m.) and the height for the first stage was 147 feet (44. 7 m.) At this height, the forms for the ore mill bunkers were disconnected and the plan dimensions reduced to 25 x 57 feet (7.6 x 17.3 m.). This upper part has a height of 94 feet (28.8 m.). The total slide distance was thus 241 feet (73.5 m.). The 10 square pillars and 12 buttresses, located within the bunkers, as well as the partition walls, were slide cast at the same time as the outer walls. Over the 94 feet (28.8 m.), the width of the pillars and buttresses change twice from about 4 to 2 feet (1.13 to 0.65 m.). The recesses for three floorings of 5 feet (1.5 m.) thickness were made in these pillars and buttresses.

The working platform rested on two layers of steel beams at right angles to each other connected centrically to the yokes. In this way the heavy loads on the platform were transferred direct to the lifting points.

About 70 hydraulic jacks were used with a total lifting force of approximately 250 tons.

The pouring time for the first stage was 17 days and 11 days for the second stage.

The average slide speed was thus about 9 feet (2.60 m.) per day. However, it decreased to about 3 feet (1 m.) per day when the recesses for the floorings were being made. It rose to a good 10 feet (3 m.) per day when the walls between the floorings with their relatively few recesses, etc., were poured.

The working crew consisted normally of 41 men per shift divided as follows: 8 carpenters, 7 iron workers, 14 concrete workers, 6 hoist operators and 6 miscellaneous workers.

The mixing station was equipped with inclined hoppers for aggregates which were distributed via a narrow gauge track, to a 23 cu. ft. (650 l.) and a 12 cu. ft. (350 l.) mixer. From there the concrete was conveyed in buckets which were lifted by two friction hoists located on the working platform. The reinforcement steel was also taken up by a friction hoist. Concrete distribution on the working platform was by wheelbarrows. All concrete was hand-tamped, in accordance with the request of the customer.

As usual after completion the jackrods were recovered by help of specially designed devices.

Fig. 36

Factories and Plants

Fig. 37

When the sponge iron plant of Uddeholms A.B. in Persberg, Sweden, (Fig. 37), was erected during the summer of 1952 by means of hydraulic slide casting, this constituted a step forward in the slip form technique.

The rapid erection of the plant was of great interest to the mining company, for which reason this technique was used as the quickest and most economical method of construction.

Previously, only slip forms with working platforms, developed for use as future forms for roofs or intermediate floorings had been made. However, in Persberg the working platform consisted of the permanent steel roof skeleton, on which plank gangways had been arranged along the walls (Fig. 38). In this way the roof was raised at the same time as the slip form and secured in its final place when the slide casting of the walls was finished.

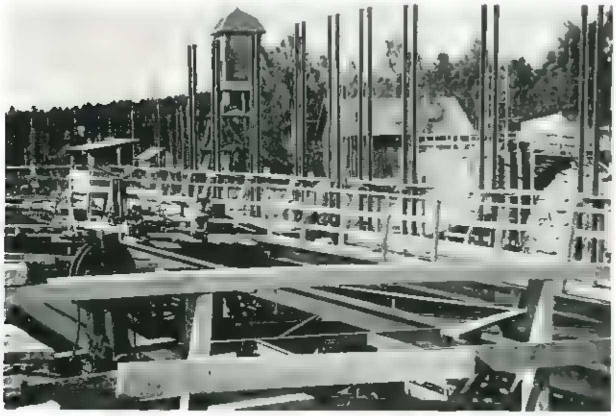

Fig. 38

Fig. 39—Inside view of roof skeleton

The ground measurement of the building is 82 x 147 feet (25 x 45 m.) and the height 99 feet (30 m.). The inside consists for the most part of a gigantic hall the outer walls of which were provided with buttresses and poured with slip form at the same time.

The sub-contractor for the roof-skeleton assembled the five large trusses and necessary transverse girders directly on the foundation.

For lifting the 107 ton heavy steel structure 60 larger jacks were used (Fig. 40); the slip form itself needed 66 small jacks. The lifting capacity, when the pumps delivered a pressure of 1400 lbs./sq. in. (100 kg./cm.^{2}) was 6 tons for the large jacks and 3 tons for the small.

After nine days the building itself was erected; then 3700 sq. yds. (3100 m.^{2}) of wall surface had been poured using 850 cu. yds. (650 m.^{3}) concrete.

At the concrete station the aggregrate was stored in hoppers then automatically weighed and emptied directly into the 1 cu. yd. (750 l.) Tornomixer. A tower crane manufactured by Wullschlaeger conveyed the concrete in buckets from the mixer to the working platform where it was received partly in barrows and partly poured directly into the forms.

The crew consisted of: 1 mixer operator, 1 crane operator, 6 men receiving concrete, 4 iron workers, 3 carpenters, 2 finishers and 2 jack operators.

The sponge iron plant in Persberg was one of the most complicated slip form works ever constructed in Sweden.

Fig. 40

Bridge Pillars

Fig. 41—With specially constructed steel forms bridge pillars of various heights were erected in 1951

Summary

SLIDING FORMS have proven to be a practical and economical method of construction for certain types of concrete structures, i.e. storage bins, water towers, mine headframes, apartment houses, bridge pillars, etc.

The advantages become apparent, when analyzed:

Monolithic Construction—The uninterrupted pouring and moving of the forms guarantee a perfectly monolithic structure. With fixed forms joints between pours are never completely water-tight and are a source of structural weakness. With sliding forms such joints and "honey-combs" are eliminated.

Better Concrete—The concrete is not poured into a deep form jeopardizing possibilities of working (vibrating) it resulting in "honey-combs" but, instead, is poured continuously in a low form with intensive vibrating.

Finer and Better Surfaces—With slip forms the surfaces are finished, smooth, dense and more capable of resisting weather conditions.

Safer and Easier Working Conditions—The reinforcing and pouring of concrete is always accomplished from a convenient, safe and accessible working platform; supervision is facilitated.

Rapid Construction—The raising speed, allowing for favorable conditions, should be approximately one foot per hour with the opportunity of a much earlier completion date than with fixed form construction.

Less Formwork—A considerable saving in material and labor.

Less Scaffolding—Only a small and simple hanging scaffold is usually needed.

The lifting of the form has hitherto most commonly been performed manually by screwing or "jacking." These methods entail several drawbacks; for one thing the labor requirement for lifting. A more serious matter is that the individual step by step lifting of the form tends to cause an uneven movement, accompanied by deformations and disturbances of the level of the form.

HYDRAULIC FORM LIFTING

To eliminate the disadvantages inherent in common methods of form raising a new method, the Concretor method, has been introduced—an entirely new system of form raising.

The Concretor method has as its objectives:

1. Reduction to the lowest possible point the manual labor connected with the lifting of the form.
2. An increase of the lifting speed.
3. To produce uniform and simultaneous ascent at the different points where the lifting power is applied.
4. Simplification of all other work in connection with slide casting, such as conveying concrete to the form, its distribution in the form, assembling, dismantling of the form and the structural parts which support it, etc.

The form lifting equipment includes a number of hydraulic, oil-operated jacks which "climb" upward on 1" (25 mm) smooth, round steel rods. All the jacks are connected by a system of pipes to a small electric oil pump; only one man is required to tend the pump and hydraulic system no matter how many jacks. This man attends to the entire lifting of the form.

STANDARD SLIDE-CASTING EQUIPMENT

Standard equipment is available for the casting of concrete structures for a number of customary purposes on the sliding-form principle, including farm silos, storage bins for grain, sand, sugar, etc. and other tower-like structures of a horizontally circular shape with internal diameters from 6 to 26 feet (1.8 –8 m) with an interval of approximately 3' (1m). This standard equipment is composed of steel plate forms and working platform of steel beams covered with plywood sections. The main components are conveniently bolted together into a unit, suspended on 3 to 6 jacks. The equipment further comprises all the machinery and implements required for the concrete work such as mixer, hoist for concrete and reinforcement rods, distributor for concrete in the form,

special truck, dismantling devices, etc. Standard equipment of this kind is tended by only two to four workers who carry out all the concrete and reinforcing work and attend to the lifting of the form. The average slide-casting rate is approx. 1 foot (0.30 m) per hour representing 24 feet (7 m) in 24 hours. A crew of 6 men, working in three shifts, are thus able to cast an 80 foot (25 m) high tower in one week. In this time is included the work of assembling and dismantling of the entire slipform equipment. Figures 4-9 show constuction both here and abroad with standard Concretor equipment.

STANDARD FORM-LIFTING EQUIPMENT FOR WOODEN SLIP-FORMS

For slip-form casting of large concrete structures, square or rectangular, or cylindrical silos and towers of other diameters than the standard ones mentioned, hydraulic jacks are used in combination with standardized steel yokes. The wooden form is suspended on these yokes. Thanks to the uniform and simultaneous lifting at all points, the slip form can be constructed quite simply and economically with a saving of material. As the yokes are low and take up a very small space, the working platform space is very ample and all points easily reached. The distribution of the concrete can thus be conveniently performed in this space to all parts of the form. The entire form-lifting equipment, including the standard yokes, can easily be adapted to any desired stuctural plan and thickness of wall.

The slip form itself is built of dressed, as a rule tongued-and-grooved, 1¼" or 1½" x 4" boards. Height of the form 3-4 feet (0.9-1.2 m). Horizontal walings for the form—one at the bottom and one at the top of each form—are usually made of 3" x 6" for a straight wall; and double, bolted, 2" x 8" or 10" for a circular wall. These walings are directly supported against the vertical legs of the yoke and transmit the pressure of the concrete against the form to the yoke. In case of small spans between the slide-cast walls, the working platform can be laid directly on the top walings of the form. When the span is longer, the supporting beams of the platform are usually placed centrically at the lifting points. This serves to avoid skew loads on the form.

A number of building structures of considerable magnitude have been constructed with this form-lifting method and equipment, the dimensions both in section and height being sometimes quite notable. Some of these varied uses are shown in the preceding sections of this catalog.

This new form lifting method affords facilities for an immense widening of the practical application of the slip form principle in concrete construction. The method is at present in use in most European countries, Africa, Australia, South America, Mexico and the United States.

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